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Abstract. The purpose of this study is to assess and differentiate between the externalities imposed on people living in rural and urban areas of Russia. The hypothesis of the study is that people living in areas with different levels of urbanization have different views on the pros and cons of mass car ownership. As a result of this study, various types of the positive and negative external effects of mass car ownership were identified. A survey was conducted on people living in Sverdlovsk Region to assess the externalities. The survey was conducted in October 2018. For the purposes of analysis, the filled questionnaires were divided on the basis of car ownership. Of the 390 respondents aged 18 and above, 62% had a car and 38% did not. The main differentiation factor in the perception of the effects is the respondents' place of residence. A relationship was proven between the size of the place of residence and the score that the respondents gave to the positive and negative effects of mass car ownership: the smaller the area, the higher they appreciate the positive effects and the lower score they give to the negative effects of mass car ownership. Consequently, the bigger the settlement where the respondents live, the smaller score they give to the positive effects and the bigger emphasis they place on the negative effects of mass car ownership. The assessment of externalities can be used to justify the amount of transport payments in urban and rural areas.

1. Introduction

The fact that today a large part of the population owns a car could be viewed as one of the most vivid characteristics of the modern world. In different countries the process of car ownership growth took place during different periods and at a different pace. In the US, the car ownership rate skyrocketed in the 1930s. In Western Europe, mass ownership became common in the 1950s-1970s. In Russia, the trend took shape much later, in the mid-1990s. Currently, growth in private car ownership has somewhat slowed down, but it has not stopped [1].

Doubtless mass car ownership has made people a lot more mobile, considerably expanding their opportunities to choose a job, a place to live and to go on vacation. The mass-produced and affordable car has opened a whole new world of opportunities to ordinary people, along with a substantial improvement in living standards.

Owning a car today has become a basic part of life for a family of any income in any country. The advantages of owning a car were so obvious to people of all income levels that mass car ownership has swept over all developed and developing countries. The one-car-family concept has been superseded by the concepts of the two-car-family and then three-car-family. In other words, new living standards

are taking shape that imply there is a car per each family member. The process of growing car ownership takes a different path in rural areas as opposed to cities. The most rapid growth has been observed in metropolitan areas. Excessive car use in the urban environment has resulted in a chronic shortage of parking space and road capacity and, eventually, in traffic congestion and overall inefficiency of city transportation systems. Rural car ownership has been growing against a more positive backdrop. Usually, the trend has not produced parking problems or widespread traffic congestion [2]. As a result, urban and rural areas experience different ratios of positive and negative externalities imposed by car ownership.

The purpose of this study is to assess and differentiate between the externalities imposed on people living in rural and urban areas of Russia. The hypothesis of the study is that people living in areas with different levels of urbanization have different views on the pros and cons of mass car ownership.

2. Another section of your paper

Active studies of theoretical substantiation, classification and evaluation of externalities relating to motor transport use were conducted only in the past 30 to 40 years. American and European authors W Baumol [2], M Delucci [3], B de Borger [4], I Mayeres [5], R Coase R [6], W Vickrey [7] and other Russian economists started to pay attention to the issue of balanced development of motor transport only in the last 10 to 15 years.

Baumol proved that any activity that includes public goods as accompanied by various externalities and internal costs [2].

Externalities are traditionally understood as factors whose benefits and costs are not reflected in the market price of goods and services, unlike internal costs that are reflected in market prices. Consequently, internal costs are covered by car users themselves, while externalities are paid for by the entire society (local community) [7].

Positive externalities are benefits that are enjoyed by a third-party as a result of an activity of another party without any pay from the former. Economic agents are, therefore, willing to pay for benefiting from positive externalities [8].

Negative externalities are a loss in the welfare of one party resulting from an activity of another party, without there being any compensation for the losing party. In this case, economic agents are prepared to pay for avoiding negative externalities [9].

At the same time, the market itself is unable to create a system of market-based prices that would encourage producers of negative externalities to reduce their impact, and consumers of positive externalities to pay for the positive external effects. Internalization of externalities make it possible to remedy this inability of the market reflect the occurring effects in pricing. Internalization of externalities is the process of incorporating externalities into the market mechanism of production that provides for their conversion into internal (private) costs that are accounted for in prices. This processes is sometimes referred to as correction of externalities [6].

The concept of externalities was first developed by Arthur Pigou [8]. He theoretically proved that resources are not distributed efficiently in the presence of negative externalities. Consequently, the state has to intervene to solve the problem of internalizing externalities. Such intervention involves imposing a tax that is set equal to the negative externalities. Under Piguo's concept, externalities are internalized through taxation [5].

Positive externalities of transport are well known [4]. These include labour mobility, fast shipping of goods, interregional cooperation and holiday and recreation opportunities, which leads to higher labour productivity.

At the same time, negative externalities intensify as vehicle ownership expands [3]. The impact is most prominent in big cities where car use increases spontaneously and people continue to prefer private cars to public transport. In such cities, the negative externalities of motor transport start to outpace the positive ones: traffic speed drops because of congestion; road accident rates go up; drivers are less observant of parking regulations; pedestrian and recreational spaces shrink to allow for bigger roads and parking lots; air quality gets worse and people's general health deteriorates, and so does

motorists' mental health.

Table 1 presents the characteristics of the key negative externalities of car use that need to be corrected through transport tax. It has to be noted that the presented externalities are the ones that are most apparent at a higher rate of car ownership when a considerable part of the population of a territory develops strong automobile dependency [10,11].

Table 1. Characteristics of key negative externalities of excessive automobile use in big cities.

No	Externality	Characteristics of externality uncompensated by car users
1	Pollution	Damage caused by exhaust gases, fuel evaporations, particle pollution, costs of ill-health
2	Traffic jams	Time lost in traffic jams; additional air emissions in traffic jams and at lower traffic speeds
3	Road accidents	Uncompensated damage to involved drivers; time lost by all travelers; uncompensated higher costs of emergency medical care and of restoring traffic after collision
4	More space for parking	Costs of uncompensated use of pedestrian and recreational spaces for parking, congested pedestrian and public transport traffic, esthetic degradation of streets and neighborhoods
5	More urban land devoted to roads	Costs of reallocating land in cities for the sake of road construction, higher prices of land for housing construction, higher cost of multi-level interchange projects
6	Noise pollution	Costs of building roadside noise barrier; costs of ill-health and increased irritability
7	Road wear	Costs of unscheduled road surface repairs due to intense traffic, time lost by all travelers because of road closures

3. Research method

Data for the study was collected in Sverdlovsk Region by means of an online survey. Sverdlovsk Region has an area of 195,000 square kilometers, and a population of 4.3 million. There are 94 municipalities, including 47 towns and 99 urban-type settlements, and 1,821 villages. The share of the urban population is quite high at 85%. The population density is 22 persons per square kilometer. People in the region traditionally earn 20% more than the national median income. Prices for cars in the Sverdlovsk Region correspond to the average prices in the country. The share of expenditures on the maintenance of a private car averages 6% of the income of a typical household [12].

Car ownership growth in Sverdlovsk Region has also outpaced the national rate. By the end of 2016, there were 361 private passenger cars per 1,000 people, which is 30% higher than the national level. An ownership level of over 300 cars per 1,000 inhabitants is usually described as mass car ownership [9]. Consequently, it is possible to conclude that the processes of mass car ownership are already prominent in Sverdlovsk Region and can be appropriately assessed.

The total length of the road network including public roads of federal, regional and inter-city jurisdiction in Sverdlovsk Region is 30,600 km. That includes 600 km of federal roads (2%), 11,000 km of regional and inter-city roads (36%), 19,000 km (62%) of roads of local significance. Surfaced roads constitute 78% of the region's road network. The density of the surfaced public road network is 124 km per 1,000 square km of the region's area, which is double the national average. Sverdlovsk Region ranks 81st in terms of the number of road traffic accidents (69 accidents per 100,000 population).

The survey questionnaire was uploaded to www.typeform.com. It was divided into three sections with a brief introduction. The introduction specified the purpose of the study and gave a definition of external effects for clarity. External effects were defined as losses (negative effects) or benefits (positive effects) that the respondents incur as a result of mass motor vehicle use in their places of

residence. An explanation was provided that the respondents do not receive compensation for the effects through the system of market prices, i.e. the cost of the effects is not incorporated into the prices of transport and other related services. Motor vehicle use was defined as the use of a privately owned car for personal reasons as well as the use of a car by other city dwellers who do not have a vehicle of their own.

Section one of the questionnaire contained personal background questions (age, gender, place of residence, possession of a driving license, possession of a personal car, frequency of public transport use). Participants in the survey were selected to be over 18 years of age, living in different towns and villages of Sverdlovsk Region. The questionnaires were sorted by the factor of car ownership. The factor of having or not having a personal car was used to increase the objectivity of responses as car owners could strongly distort the ratio of external effects by focusing primarily on the positive ones. There were also questions about the accessibility and quality of public transport in the area of the respondents' residence.

Section two contained assessment of the positive effects of mass car ownership in the area of the respondents' residence on a scale of 1-10. Section three contained assessment of the negative effects of car ownership in the area of the respondents' residence on a scale from one to ten. The list of the effects in the questionnaire was not exhaustive, with the respondents being able to add more effects to it and assign a score to them. A total of 390 persons were surveyed. Their responses were grouped by area of residence: (a) big cities with a population of over 100,000; (b) small towns with 10,000 to 100,000 inhabitants; (b) villages with less than 10,000 inhabitants.

4. Analysis of the survey results

The survey was conducted in October 2018. For the purposes of analysis, the filled questionnaires were divided on the basis of car ownership. Of the 390 respondents aged 18 and above, 62% had a car and 38% did not. The distribution reflects the structure of the region's adult population in terms of car ownership. The respondents' distribution by place of residence was as follows: 55% lived in big cities; 25% in small towns; 20% in villages. This broadly reflects the current level of car ownership and the population structure in Sverdlovsk Region, which is an indication of the representativeness of the sample.

4.1. Analysis of the positive effects of mass car ownership

Table 2 presents the scoring assessment of the positive effects of car ownership. The results are grouped according to ownership (non-ownership) of a car by respondents and by their place of residence.

Table 2. Assessment of the positive externalities of mass car ownership by residents of various territories (on a 1-to-10 scale, with 1 meaning the absence of an effect, and 10 - the maximum level of the effect).

Externality	City residents		Residents of medium-size settlements		Residents of small settlements	
	owning a car	not owning a car	owning a car	not owning a car	owning a car	not owning a car
1. Higher labor mobility	4.2	2.1	7.2	5.1	9.8	6.0
2. More vacation opportunities	6.4	3.2	7.3	5.1	9.1	5.3
3. Shopping and household chores made easier	4.4	3.4	6.2	4.0	8.3	5.1
4. Keeping in touch with extended family made easier	3.7	3.1	5.6	4.1	9.1	6.4
5. More options for choosing a place to live	3.5	2.3	6.2	3.4	9.3	7.0
6.Socio-cultural communication made easier	3.8	1.6	5.0	2.5	8.1	5.2

7. Comfortable travelling in bad weather	6.1	5.0	8.4	5.1	9.3	6.0
Total score	32.1	20.7	45.9	29.3	63.0	41.0

It needs to be noted that different groups of population perceive the same positive externalities of mass car ownership differently. The place of residence is used as the main differentiation factor for respondents. As a result, the following correlation has been observed: the smaller the area a respondent lives in, the higher score he or she assigns to the positive effects of mass car ownership. Consequently, the bigger the city, the lesser is the score assigned to the positive effects of car ownership. One of the reasons for such different assessments of the positive externalities of mass car ownership could be the fact that the benefits are overshadowed by the negative effects of mass car ownership that are more pronounced in big cities. The value of the assigned scores is also influenced by the accessibility of public transport as an alternative to privately owned cars. The more accessible public transport is, the smaller is the score that respondents give to the positive effects of mass car ownership. As a rule, public transport is more accessible in big cities, consequently, the presence of such an alternative as affordable public transport affects the perception of the positive effects of car ownership.

Another significant factor in assigning different scores to the positive externalities is the ownership or non-ownership of a personal car by respondents. Those of them who do not own a car give lower assessment of the positive externalities than those who have one. The difference in assigned scores is particularly noticeable when it comes to assessing such effects as increased labor mobility and additional vacation opportunities. It is possible to suppose that the assessment by people who do not own a car are more objective, while car owners tend to overestimate the positive effects of mass car ownership.

Generally speaking, the scores assigned by car owners living in rural areas to the positive externalities of mass car ownership tend to be three times higher than those given by car owners residing in big cities. Rural dwellers who do not own a car tend to assign twice as high a score to the positive externalities as non-owners of cars living in big cities.

4.2. Analysis of the negative effects of mass car ownership

Table 3 presents the scoring assessment of the negative effects of car ownership. The results are grouped according to the ownership (non-ownership) of a car by respondents and by their place of residence. The perception of the negative effects of mass car ownership also differs depending on where the respondents live. In this case, however, the dependence is opposite: people living in small towns and villages assign a much lower score to the negative effects than urban dwellers do. Inhabitants of big cities assign the negative effects almost twice as high a score as people living in rural areas. This is natural because all the negative effects are more pronounced in areas with a high density of cars. Such disproportion of opinions occurs both in car owners and those who do not have a car.

Table 3. Assessment of the negative externalities of mass car ownership by residents of various territories (on a 1-to-10 scale, with 1 meaning the absence of an effect, and 10 - the maximum level of the effect).

Externality	City residents		Residents of medium-size settlements		Residents of small settlements	
	owning a car	not owning a car	owning a car	not owning a car	owning a car	not owning a car
1. Traffic jams	9.9	7.2	8.5	6.2	6.3	4.0
2. Increasing amount of land occupied by parking	7.4	9.3	4.1	6.2	1.3	2.4
3. Higher traffic accident	7.2	4.2	7.5	3.6	8.1	2.4

rates						
4. Air pollution	5.1	9.2	4.3	7.5	3.4	6.2
5. Increased tear and wear on roads	4.3	6.4	3.4	4.9	2.2	4.1
6. Increased levels of noise pollution	5.4	8.5	2.1	4.6	1.2	3.7
7. More land occupied by roads	3.4	3.5	3.2	3.4	2.9	3.2
Total score	42.7	48.3	33.1	36.4	25.4	26.0

Another dependence was observed: car owners tended to give higher scores to all positive effects, while those who do not own a car assigned higher scores to the negative effects. There are only two externalities, though, that car owners are more negative about - road congestion and higher road accident rates. All the other negative effects do not get so much attention from car owners. Only people living in rural areas assigned comparatively uniform scores to the negative effects, while urban dwellers assessed the negative effects differently depending on whether they own a car or not. One could suppose that the assessment by those who do not own a car is more objective, while those who has a car tend to understate the negative effects of mass car ownership.

5. Discussion

The perception of the positive and negative externalities of mass car ownership makes it possible to differentiate among them with regard to residents of different territories. The survey results enable the authors to identify three fundamentally different situations that are observed in Sverdlovsk Region. The situations demonstrate different ratios of the positive and negative externalities (figure 1).

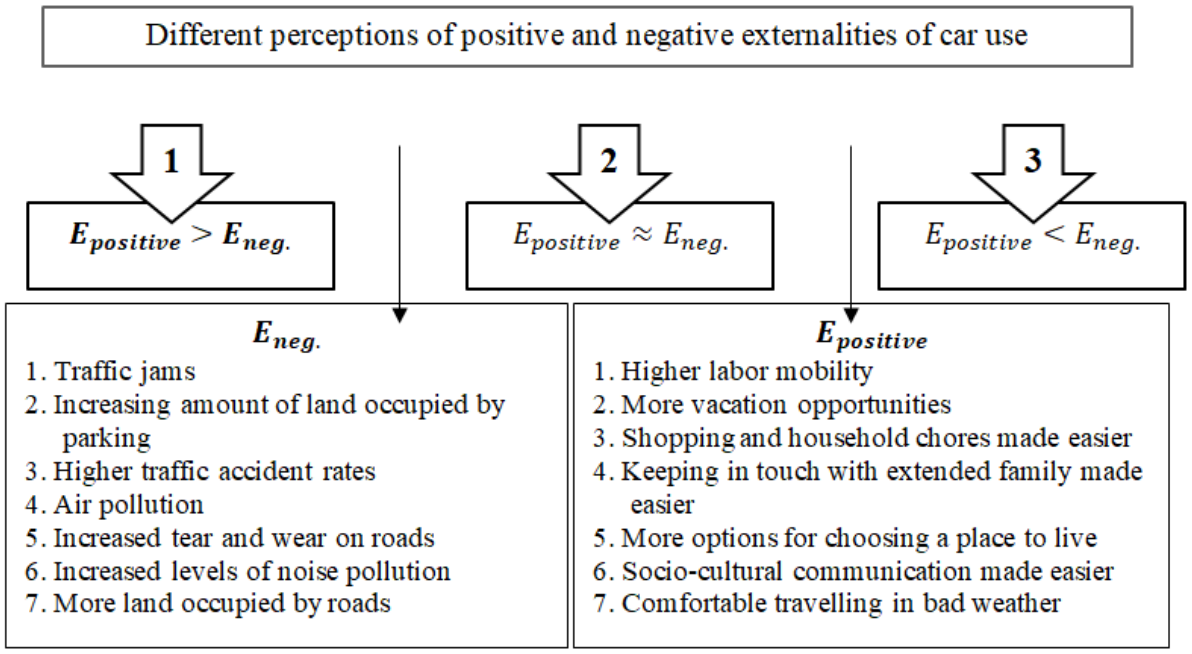

Figure 1. Different perception of positive and negative effects of personal car use by people living in different areas.

As a result of the survey, three principally different situations were distinguished:

- A situation when the sum total of the positive effects of mass car ownership in an area exceeds the sum total of the negative externalities. The situation is typical of remote rural areas that are far away from urban agglomerations and district centers. Such areas have low car ownership

levels and an underdeveloped road network. Transport-related charges in such areas must be set at a low level to stimulate demand for privately owned cars. Serving as the main means of personal mobility for rural inhabitants, cars will be more efficient in rural settlements than public transport.

- A situation when the sum total of the positive external effects of mass car ownership is comparable to the sum total of the negative external effects. The situation is typical of territories that are close to urban agglomerations and of small towns and district centers that have a medium level of car ownership and sufficiently good road networks. Transport-related charges in such areas must be set at a medium level to nurture neutral reactions in dwellers to car use and public transport. Personal mobility in such areas should be delivered by both privately owned car and public transport.
- A situation when the sum total of the positive effects of mass car ownership in an area is less than the sum total of the negative external effects. The situation is typical of large cities and urban agglomerations with a high level of car ownership and a more developed road network. Transport-related charges in such areas must be increased so that they serve as an instrument of lowering demand for car use in the urban environment. Personal mobility of people living in such areas should be delivered by public transport.

We investigated this ratio for Russia. The ratio of these effects may be different in different countries. Mercure investigated the effectiveness of fiscal policy in 6 different countries. The car purchase choices are known to be strongly socially determined, and this sector is highly diverse due to significant socio-economic differences between consumer groups [11].

The different ratio of positive and negative effects of mass car ownership will lead to a different structure of the social optimum of passenger flows in urban and rural areas. In article [12] we investigated the structure of the social optimum for urban agglomerations in Russia. This social optimum is achieved while minimizing the total transport costs of citizens. Minimum transport costs in the city will be provided with maximum use of public transport and a minimum use of personal transport. In rural areas, the social optimum of passenger flows will be different. The minimum total transport costs will be provided with maximum use of personal transport and minimum use of public transport.

6. Conclusion

The hyperactive growth of the privately owned car fleet makes it particularly timely to conduct theoretical and practical research into the external effects of mass car ownership. As a result of this study, various types of the positive and negative external effects of mass car ownership were identified.

A survey was conducted on people living in Sverdlovsk Region to assess the externalities. Analysis of the obtained results made it possible to identify two main differences in the perception of the negative and positive effects of mass car ownership.

The main differentiation factor in the perception of the effects is the respondents' place of residence. A relationship was proven between the size of the place of residence and the score that the respondents gave to the positive and negative effects of mass car ownership: the smaller the area, the higher they appreciate the positive effects and the lower score they give to the negative effects of mass car ownership. Consequently, the bigger the settlement where the respondents live, the smaller score they give to the positive effects and the bigger emphasis they place on the negative effects of mass car ownership.

The second differentiation factor in the perception of the external effects is the respondents' attitude to private car ownership. Those who own a car tend to assign a higher score to the positive effects and a lower score to the negative effects of mass car ownership compared to those who do not own a car.

The authors have distinguished three different situations when the scoring ratio of the positive and negative effects of car use depends on the respondents' place of residence. Inhabitants of rural areas assigned higher scores to the positive effects than to the negative effects. In small urban areas people

assigned comparable scores to both the negative and positive effects. In big cities the negative effects were ranked higher than the positive effects.

One can therefore conclude that the hypothesis that people living in areas with different levels of urbanization have different views on the pros and cons of mass car ownership has been proven.

The direction of further research is to identify the dependence of the perception of various externalities effects depending on other factors: the level of income of the respondents and their level of education.

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